We Claim:

1. A method of forming a configurable array of probes comprising:

generating movable optical traps within a vessel;

providing at least two probes, each with a known binding or reactivity characteristic, within the vessel;

selecting at least two probes for inclusion in an array;

containing each selected probe with an optical trap to form the array; and,

tracking at least one of the probes using the optical trap which contains it.

2. The method of claim 1, further comprising altering the position of at least one probe in the array by moving the optical trap containing the probe.

3. The method of claim 1, wherein the optical traps are formed of two or more of optical tweezers, optical vortices, optical bottles, optical rotator, or light cages.

4. The method of claim 2, wherein each optical trap is independently movable.

5. The method of claim 2, wherein the movement of each optical trap is controlled by a computer.

6. The method of claim 4, wherein the movement of each optical trap is controlled by a computer.

7. The method of claim 4, wherein at least one of the probes is selected by measuring a spectrum of the at least one probe and using the spectrum measurement to select the probe.

8. The method of claim 4, wherein at least one of the probes is selected by segregating the probes, by the known characteristics, at pre-determined locations within the vessel and using the location of each probe to select the probe.

9. The method of claim 8, further comprising placing the selected probes into at least one physical sub-cell disposed within the vessel.

10. The method of claim 9, wherein the sub-cell is an optical sub-cell.

Sub A15

11. The method of claim 1, wherein the probe is a biological material.

12. The method of claim 1, wherein the probe is a chemical material.

13. The method of claim 11, wherein the target is a biological material.

Sub B2

14. The method of claim 11, wherein the target is a chemical material.

15. The method of claim 12, wherein the target is a biological material.

16. The method of claim 12, wherein the target is a chemical material.

17. The method of claim 11 wherein the probe is an oligonucleotide, a polynucleotide, a chemical compound, a protein, a saccharide, a ligand, a cell, an antibody, an antigen, a cellular organelle, a lipid, a blastomere, an aggregations of cells, a microorganism, a peptide, cDNA, RNA or combinations thereof.

Sub A16

18. The method of claim 13 wherein the biological material is an oligonucleotide, a polynucleotide, a chemical compound, a protein, a saccharide, a ligand, a cell, an antibody, an antigen, a cellular organelle, a lipid, a blastomere, an aggregations of cells, a microorganism, a peptide, cDNA, RNA or a combination thereof.

19. The method of claim 15 wherein the target is selected from one or more of the group consisting of an oligonucleotide, a polynucleotide, a chemical compound, a protein, a saccharide, a ligand, a cell, an antibody, an antigen, a cellular organelle, a lipid, a blastomere, an aggregations of cells, a microorganism, a peptide, cDNA, RNA or a combination thereof.

20. The method of claim 1 further comprising the probes are all bound to a substrate.

21. The method of claim 1 further comprising the probes are all unbound to a substrate.

22. The method of claim 1 further comprising at least some probes are bound to a substrate and at least some probes are unbound to substrate.

23. A method of forming a dynamic, configurable array of probes the method comprising:

generating movable optical traps within a vessel;

monitoring the optical traps;

providing at least two probes, each with a known binding or reactivity characteristic, within the vessel;

selecting at least two probes for inclusion in an array;

containing each selected probe with an optical trap to configure the array; and,

tracking at least one of the probes using the optical trap which contains it.

Sub A18

24. The method of claim 20, further comprising altering the position of at least one probe in the array by moving the optical trap containing the probe.

25. The method of claim 23, the method further comprising producing an optical data stream.

26. The method of claim 24, wherein each optical trap is independently movable.

27. The method of claim 24 wherein the movement of each optical trap is controlled by a computer.

Sub A19

28. The method of claim 25, the method further comprising receiving the optical data-stream with a computer.

29. The method of claim 28, the method further comprising analyzing the optical data stream with the computer.

30. The method of claim 27, wherein the computer directs the movement of at least one optical trap based on the analysis of the optical data stream.

31. The method of claim 25, further comprising converting the optical data-stream to a video signal.

Sub D19 cont'd.

32. The method of claim 31, further comprising receiving the video signal with a computer.

33. The method of claim 32, further comprising analyzing the video signal with the computer.

34. The method of claim 33, further comprising using the computer to direct the movement of one or more optical traps based on the analysis of the video signal.

Sub D22

35. The method of claim 31, wherein the video signal is used to produce an image.

36. The method of claim 35, further comprising an operator viewing the image and directing the movement of one or more optical traps based on the viewing of that image.

37. The method of claim 25, further comprising analyzing the spectrum of the optical data-stream.

Sub D20

38. The method of claim 37, the method further comprising using a computer to direct the movement of one or more optical traps based on the analysis of spectrum of the optical data stream.

39. The method of claim 23, further comprising forming two or more of optical tweezers, optical vortices, optical bottles, optical rotators, or light cages.

40. The method of claim 26 wherein the movement of each optical trap is controlled by a computer.

41. The method of claim 23, wherein at least one of the probes is selected measuring a spectrum of at least one probe and using the spectral measurement to select the probe.

SUB A20 cont.

42. The method of claim 24, wherein at least one of the probes is selected segregating the probes, by the known characteristics, at pre-determined locations within the vessel and using the location of each probe as the criteria to select the probe.

43. The method of claim 42, further comprising placing the selected probes into at least one physical sub-cell disposed within the vessel.

SUB B32

44. The method of claim 42, wherein the sub-cell is an optical sub-cell.

45. The method of claim 23, wherein the probe is a biological material.

SUB A21

46. The method of claim 23, wherein the probe is a chemical material.

47. The method of claim 46, wherein the target is a biological material.

SUB B33

48. The method of claim 46, wherein the target is a chemical material.

49. The method of claim 45, wherein the target is a biological material.

50. The method of claim 45, wherein the target is a chemical material.

51. The method of claim 45 wherein the probe is an oligonucleotide, a polynucleotide, a chemical compound, a protein, a saccharide, a ligand, a cell, an antibody, an antigen, a cellular organelle, a lipid, a blastomere, an aggregations of cells, a microorganism, a peptide, cDNA, RNA or combination thereof.

SUB A22

52. The method of claim 47 wherein the target is an oligonucleotide, a polynucleotide, a chemical compound, a protein, a saccharide, a ligand, a cell, an antibody, an antigen, a

cellular organelle, a lipid, a blastomere, an aggregations of cells, a microorganism, a peptide, cDNA, RNA or a combination thereof.

Sub B22 cont'd

53. The method of claim 49 wherein the target is selected from one or more of the group consisting of an oligonucleotide, a polynucleotide, a chemical compound, a protein, a saccharide, a ligand, a cell, an antibody, an antigen, a cellular organelle, a lipid, a blastomere, an aggregations of cells, a microorganism, a peptide, cDNA, RNA or a combination thereof.

54. The method of claim 23 wherein the probes are all bound to a substrate.

55. The method of claim 23 wherein the probes are all unbound to a substrate.

56. The method of claim 23 wherein at least some probes are bound to a substrate and at least some probes are unbound to substrate.

Sub B23

57 A method of assaying biological material the method comprising:

generating movable optical traps within a vessel;

providing a fluid media in the vessel;

providing at least two probes, each with a known characteristic for binding or reacting with a biological tarket, within the vessel;

selecting at least two probes for inclusion in an array;

containing each selected probe with the optical trap;

introducing into the vessel biological targets; and,

determining the reaction or lack thereof, of each of the probes with each of the targets.

58. The method of claim 57, further comprising tracking each probe throughout the assay using the optical trap which contains it.

59. The method of claim 57, wherein the probe is a biological material.

60. The method of claim 57, wherein the probe is a chemical material.

61. The method of claim 59 wherein the probe is an oligonucleotide, a polynucleotide, a chemical compound, a protein, a saccharide, a ligand, a cell, an antibody, an antigen, a cellular organelle, a lipid, a blastomere, an aggregation of cells, a microorganism, a peptide, cDNA, RNA or combination thereof.

62. The method of claim 57 wherein the target is an oligonucleotide, a polynucleotide, a chemical compound, a protein, a saccharide, a ligand, a cell, an antibody, an antigen, a cellular organelle, a lipid, a blastomere, an aggregation of cells, a microorganism, a peptide, cDNA, RNA or combination thereof.

Sub A24

63. A method of assaying biological material comprising:

generating movable optical traps within a vessel;

providing a fluid media in the vessel;

monitoring the optical traps;

providing at least two probes, each with a known characteristic for binding or reacting with a biological target, within the vessel;

selecting at least two probes for inclusion in an array;

containing each selected probe with the optical trap;

introducing into the vessel biological targets; and,

determining the reaction or lack thereof, of each of the probes with each of the targets.

64. The method of claim 63, further comprising tracking each probe throughout the assay using the optical trap which contains it.

65. The method of claim 63 further comprising altering the position of at least one probe in the array by moving the optical trap containing the probe.

66. The method of claim 63 further comprising producing an optical data stream.

67. The method of claim 65, wherein the movement of each optical trap is wherein each optical trap is movable independently of the other probes.

68. The method of claim 65 wherein the movement of each optical trap is controlled by a computer.

69. The method of claim 66 further comprising receiving the optical data-stream with a computer.

SUB A34 cont.

70. The method of claim 69 further comprising analyzing the optical data stream with the computer.

71. The method of claim 70 further comprising using a computer to direct the movement of one or more optical traps based on the analysis of the optical data stream.

72. The method of claim 66 further comprising converting the optical data-stream to a video signal.

73. The method of claim 72 further comprising receiving the video signal with a computer

74. The method of claim 73 further comprising analyzing the video signal with the computer.

75. The method of claim 74 further comprising using the computer to direct the movement of one or more optical traps based on the analysis s of the video signal .

Sub B2

76. The method of claim 72, wherein the video signal is used to produce an image.

77. The method of claim 76 further comprising an operator viewing the image and directing the movement of one or more optical traps based on the viewing of that image.

Sub A35

78. The method of claim 66 further comprising analyzing the spectrum of the optical data-stream.

Sub B25 cont.

79. The method of claim 78 further comprising using a computer to direct the movement of one or more optical traps based on the analysis of spectrum of the optical data stream.

80. The method of claim 63 further comprising forming two or more different classes of optical traps selected from the group consisting of optical tweezers, optical vortices, optical bottles, optical rotators, and light cages.

81. The method of claim 63 wherein at least one of the probes is bound to a substrate.

82. The method of claim 63 wherein at least one of the probes is unbound to a substrate.

Sub B26

83. The method of claim 81, wherein all the substrates binding probes having the same known characteristic contain the same label.

Sub B

84. The method of claim 83, wherein the label is a wavelength specific material within the substrate which responds to light in a specific range of wavelengths.

85. The method of claim 84, wherein at least one of the probes is selected by measuring the spectral response of at least one probe and using the spectral measurement to decide to contain the probe.

Sub B27

86. The method of claim 63, wherein at least one probe is accomplished by segregating the probes, by the known characteristics, at pre-determined locations within the vessel and using the location of each probe to select the probe.

87. The method of claim 63 further comprising placing the selected probes into at least one physical sub-cell disposed within the vessel.

88. The method of claim 86 wherein the sub-cell is an optical sub-cell.

89. A method of forming a configurable array of probes comprising:

generating movable optical traps within a vessel;

providing at least two probes, each with a known binding or reactivity characteristic, within the vessel; and,

configuring an array of at least two probes by selecting each probe with an optical trap.

90 A method of forming a configurable array of probes comprising:

directing a focused beam of light at a beam altering optical element to form a plurality of beamlets;

SUB D27 cont.

overlapping the beamlets at the back aperture of a focusing lens;

passing the beamlets through the focusing lens and converging the beamlets to generate movable optical traps within the vessel;

providing at plurality of probes, each with a known binding or reactivity character, within the vessel;

selecting at least two probes for inclusion in the array;

containing each selected probe with the optical trap; and,

altering the position of at least one probe by moving the optical trap containing the probe.

91. The method of claim 90 wherein the beam altering optical element has a static surface.

92. The method of claim 91 wherein the static surface is comprised of two or more discreet non-homogeneous regions.

93. The method of claim 92 wherein the position of at least one probe trap is altered by changing the discreet non-homogeneous region of the static surface receiving the beam of light.

94. The method of claim 91 wherein the static surface is continuously varying.

95. The method of claim 91 wherein the position of the at least one optical trap is altered by changing the region of the static surface receiving the beam of light .

96. The method of claim 91 wherein the beam altering optical element is a grating, a diffraction grating, a reflective grating, a transmissive grating, a hologram, a stencil, a light shaping holographic filter, a polychromatic hologram, a lens, a mirror, a prism, a waveplate and a hologram.

97. The method of claim 92 wherein each discreet non-homogeneous region is a grating, a diffraction grating, a reflective grating, a transmissive grating, a hologram, a stencil, a light shaping holographic filter, a polychromatic hologram, a lens, a mirror, a prism, a waveplate and a hologram.

Sub F127 cont.

98. The method of claim 90 wherein the beam altering optical element is dynamic.

99. The method of claim 98 wherein the position of the at least one optical trap is altered by varying the dynamic beam altering optical element.

100. The method of claim 99 wherein varying the dynamic beam altering optical element alters the phase profile of the at least one beamlet.

101. The method of claim 100, wherein the optical trap generated by the change in phase profile is an optical tweezer, a optical vortice, an optical bottle, an optical rotator, and a light cage.

102. The method of claim 93 wherein changing the discreet non-homogeneous region alters the phase profile of the at least one beamlet.

103. The method of claim 102, wherein the optical trap generated by the change in phase profile is an optical tweezer, an optical vortice, an optical bottle, an optical rotator, and a light cage.

104. A method of assaying a biological material comprising:

generating movable optical traps within a vessel;

providing a fluid media in the vessel;

monitoring the optical traps;

providing biological material within the vessel;

illuminating the biological material with a source suitable for spectral measurement;

measuring the spectrum of the biological material

using the spectral measurements to select the biological material to use as probes;

containing the selected biological probes with an optical trap;

introducing into the vessel biological targets; and,

determining the reaction or lack thereof, of each of the probes with each of the targets.

105. A system for assaying target materials using configurable probes comprising:

a focused beam of light;

an illumination source;

an optical device comprising:

a beam splitter for receiving and redirecting the focused beam of light into two directions;

at least one beam altering optical element which receives the focused beam of light that has been redirected into one of the directions and diffract it into at least two beamlets;

a focusing lens with a back aperture;

a plurality of independently movable optical traps resulting from substantially overlapping each beamlet at the back aperture of the focusing lens and passing each beamlet therethrough;

a substantially transparent subject cell for containing the target materials to be assayed and targets into which the optical traps are formed;

an optical data stream resulting from illumination source and the focused beam that has been redirected into the second of the directions;

a fluid medium within the subject cell;

a means for transferring probes into the subject cell;

a means for transferring targets into the subject cell; and,

a means for tracking the movement and contents of each optical trap.

106. The system of claim 105 wherein the means for transferring probes into the subject cell is an inlet port.

107. The system of claim 105 wherein the means for transferring targets into the subject cell is an inlet port.

108. The system of claim 106 wherein the means for transferring targets into the subject cell is the same inlet port as is used for transferring probes into the subject cell.

109. The system of claim 105 wherein the means for transferring probes out of the subject cell is an outlet port.

110. The system of claim 105 wherein the means for transferring targets out of the subject cell is an outlet port.

111. The system of claim 106 wherein the means for transferring targets into the subject cell is the same outlet port as is used for transferring probes out of the subject cell.

112. The system of claim 105 wherein the means for transferring probes into the subject is selected from the group consisting of, movement by optical traps, flow channels and micro-capillaries.

113. The system of claim 105 wherein the means for transferring targets into the subject is selected from the group consisting of, movement by optical traps, flow channels and micro-capillaries.

114. The system of claim 105 wherein the means for transferring probes out of the subject is selected from the group consisting of, movement by optical traps, flow channels and micro-capillaries.

115. The method of claim 104 wherein the targets are selected from one or more of the group consisting of oligonucleotides, polynucleotides, chemical compounds, proteins, saccharids, ligands, cells, antibodies, antigens, cellular organelles, lipids, blastomeres, aggregations of cells, microorganisms, peptides, cDNA and RNA.

116. The system of claim 105 wherein the means for transferring targets out of the subject is selected from the group consisting of, movement by optical traps, flow channels and micro-capillaries.

117. The system of claim 105, wherein the beam altering optical element is dynamic and which firtuer comprises:

a computer to control the function of the beam altering optical element; and,

a computer is the means to maintain a record of each probe contained in each optical trap.

118. The system of claim 105, wherein the means for tracking the movement and contents of each optical trap is accomplished by the pre-determined movement of each optical trap as encoded by the beam altering optical element.

119. The system of claim 105 further comprising:

transferring at least two probes, each with a known characteristic, to the subject cell; and,

containing each probe, selected for use in the assay, with the gradient forces of an optical trap;

120. The system of claim 119 further comprising transferring targets which may be reactive to some of the probes into the subject cell.

121. The system of claim 119 wherein at least one of the probes is bound to a substrate.

122. The system of claim 119 wherein at least one of the probes is unbound to a substrate.

123. The system of claim 119, wherein the probe is a biological material of known composition that is capable of selectively binding to, or reacting with, the target.

124. The system of claim 119, wherein the probe is a chemical material of known composition that is capable of selectively binding to, or reacting with, the target.

125. The system of claim 123, wherein the target is a biological material capable of selectively binding to, or reacting with, a probe.

126. The system of claim 123, wherein the target is a chemical material capable of selectively binding to, or reacting with, a probe.

127. The system of claim 124, wherein the target is a biological material capable of selectively binding to, or reacting with, a probe.

128. The system of claim 124, wherein the target is a chemical material capable of selectively binding to, or reacting with, a probe.

129. The system of claim 123 wherein the biological material of the probe is selected from one or more of the group consisting of oligonucleotides, polynucleotides, chemical compounds, proteins, peptides, cDNA and RNA.

130. The system of claim 125 wherein the biological material of the target is selected from one or more of the group consisting of oligonucleotides, polynucleotides, chemical compounds, proteins, saccharids, ligands, cells, antibodies, antigens, cellular organelles, lipids, blastomeres, aggregations of cells, microorganisms, peptides, cDNA and RNA.

131. The system of claim 127 wherein the biological material of the target is selected from one or more of the group consisting of oligonucleotides, polynucleotides, chemical compounds, proteins, saccharids, ligands, cells, antibodies, antigens, cellular organelles, lipids, blastomeres, aggregations of cells, microorganisms, peptides, cDNA and RNA.

132. The system of claim 105 wherein the movement of at least on optical trap is selected from one or more of the group consisting of rotation in a fixed position, rotation in a non-fixed position, two dimensional and three dimensional, continuous and stepped.

133. The system of claim 105 further comprising the selective movement of at least one of the optical traps.

134. The system of claim 124 further comprising changing the beam altering optical element.

135. The system of claim 134 wherein the beam altering optical element has a static surface.

136. The system of claim 135 wherein the static surface is movable to selectively align the focused beam of light with a selected portion of the static surface.

137. The system of claim 136 wherein the static surface is comprised of two or more discreet non-homogeneous regions.

138. The system of claim 137 wherein the position of at least one optical trap is altered by changing the selection of the discreet non-homogeneous region of the static surface receiving the beam of light

139. The system of claim 135 wherein the static surface is substantially continuously varying.

140. The system of claim 136 wherein the beam altering optical element is selected from at least one of the group consisting of gratings, diffraction gratings, reflective gratings, transmissive gratings, holograms, stencils, light shaping holographic filters, polychromatic holograms, lenses, mirrors, prisms, waveplate and holograms.

141. The system of claim 137 wherein each discreet non-homogeneous region is selected from at least one of the group consisting of gratings, diffraction gratings, reflective gratings, transmissive gratings, holograms, stencils, light shaping holographic filters, polychromatic holograms, lenses, mirrors, prisms, waveplate and holograms.

142. The system of claim 134 wherein the beam altering optical element is dynamic.

143. The system of claim 142 wherein varying the media of the dynamic beam altering optical element alters the position of the at least one optical trap.

144. The system of claim 142 wherein varying the media of the dynamic beam altering optical element alters the phase profile of the at least on beamlet.

145. The system of claim 144, wherein the optical trap generated by the change in phase profile selected from the group consisting of optical tweezers, optical vortices, optical bottles, optical rotators, and light cages.

146. The system of claim 137 wherein changing the selection of the discreet non-homogeneous region alters the phase profile of the at least on beamlet.

147. The method of claim 146, wherein the optical trap generated by the change in phase profile is selected from the group consisting of optical tweezers, optical vortices, optical bottles, optical rotators, and light cages.

148. The system of claim 142 wherein the beam altering optical element is selected from at least one of the group consisting of variable computer generated diffractive pattern, variable phase shifting matter, variable liquid crystal phase shifting arrays, micro-mirror arrays, piston mode micro-mirror arrays, spatial light modulators, electro-optic deflectors, accousto-optic modulators, deformable mirrors and reflective MEMS arrays.

149. The system of claim 142 further comprising a computer to selectively control the dynamic beam altering optical element.

150. The system of claim 119, further comprising

a physical sub-cell within the subject cell into which one or more probes with the same characteristic are segregated; and,

using an optical trap to contain a selected probe from a sub-cell.

151. The system of claim 119, further comprising:

an optical sub-cell within the subject cell, formed of optical traps, into which one or more probes with the same characteristic are segregated; and,

using an optical trap to contain a probe from a sub-cell.

152. The system of claim 150, further comprising a computer to change the beam altering optical element to move an optical trap to contain the probe.

153. The system of claim 119, wherein the:

the transfer of each probes is sequential; and,

the containment of each transferred probe is correspondingly sequential.

154. The system of claim 153, further comprising a computer to change the beam altering optical element to move an optical trap to sequentially contain the probe.

155. The system of claim 120, further comprising a computer to change the beam altering optical element thereby moving at least one optical trap containing a probe within the subject cell.

156. The system of claim 105 wherein the focused beam of light is a laser beam with a wavelength in the visible green spectrum.

157. The system of claim 105 wherein the focused beam of light is a laser beam with a wavelength in the visible blue spectrum.

158. The system of claim 105 wherein the focused beam of light is a laser beam with a wavelength in the visible red spectrum.

159. The system of claim 105 wherein the focused beam of light has a wavelength selected from the range of about 400 nm to about 1.06 .mu.m.

160. The system of claim 156 wherein the focused beam of light is a laser beam.

161. The system of claim 105 further comprising a computer adapted to receive the optical data-stream.

162. An apparatus to form an array of optical traps comprising:

a focused beam of light;

a beam altering optical element which receives the focused beam of light and defracts it into at least two beamlets;

a housing with one or more light channels formed therein;

a first mirror which reflects the beamlets through a light channel in the housing;

a first set of transfer optics within the light channel, aligned to receive the beamlets reflected off the first mirror;

a second set of transfer optics within the light channel, aligned to receive the beamlets from the first set of transfer lenses;

a second light channel communicating at one end with the first light channel and at its other end with a third light channel;

a second mirror placed at the intersection of the first light channel and the second light channel, aligned to receive beamlets passing through the second set of transfer optics;

a focusing lens with a back aperture;

a third mirror interposed within the third light channel, whereby beamlets traveling from the second are reflected to the back aperture of a focusing lens; and,

a plurality of independently movable optical traps formed by the gradient conditions resulting from each beamlet passing from the back aperture through the focusing lens.

163. The apparatus of claim 162, wherein the third mirror is a dichroic beam splitter; and An optical data stream is produced when the beamlets reflect off the dichroic mirror.

164. The apparatus of claim 163 further comprising an illumination source opposite the top of the focusing lens.

165. The apparatus of claim 162 wherein each set of transfer optics is selected from the group consiting of symmetrical air spaced singlets and symmetrical air spaced doublets.

166. The apparatus of claim 162 wherein each lens selected from the group consisting of convex lens, concave lenses.

167. The apparatus of claim 162 wherein the first and second set of transfer optics are symmetrical air spaced doublets and spaced at a distance to act in combination as a telephoto lens.

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